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SBIR PROJECT AF86-092 PHASE I

FINAL REPORT

VOLUME I

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The purpose of this Small Business Innovation Research (SBIR) Program was to conduct a survey of possible systems level technology assessment approaches and to recommend a suitable technique and approach for a Phase II methodology development activity. The survey consisted of the review of several thousands of existing computer simulation models and methodologies for applicability to systems level technology assessment. The models were categorized according to purpose and scope. A bibliography of relevant models was created, including an annotated bibliography of a subset of the overall bibliography. Several models most nearly suited to the task of systems level technology assessment were then evaluated for their applicability to TXAA requirements. The result was the recommendation that a new simulation model be created.

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Attachment #1

SBIR PROJECT AF88-092 PHASE I

SYSTEMS LEVEL TECHNOLOGY ASSESSMENT METHODOLOGY FOR STOVL TYPE AIRCRAFT

FINAL REPORT

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VOLUME I
Executive Summary and Project Report

PREFACE

This study was conducted by Jordan and Associates, Knoxville, Tennessee, under Air Force Contract F33615-88-C-3800. It was sponsored by the Analysis Branch of the Technology Exploitation Directorate, U.S. Air Force Wright Aeronautical Laboratories, Air Force Systems Command. It is a Phase I effort under the Small Business Innovation Research Program, Project AF88-092. It was administered under the technical coordination of John L. Byrnes, contract monitor and principal government analyst.

Study results are contained in two volumes:

Volume I	Executive Summary and Project Report
Volume II	Bibliography

The contractor report number is JOR 88-01. This report covers work performed between 01 July 1988 and 23 December 1988.

Jordan and Associates was the sole performer of this effort. Michael F. Jordan was the principal investigator. Elaine Hubbard and Deanna Sheffer also contributed to the study effort.

EXECUTIVE SUMMARY

The scope of the project is quoted from the solicitation notice:

> Phase I activity will include a survey of possible systems level technology assessment approaches including problem flexibility, ease of use, credibility, etc., and a recommended technique. This will lead to Phase II activities consisting of the final development including algorithms, data base, coding, validation, documentation and transition of the methodology to the Air Force Wright Aeronautical Laboratories.

The overall objectives of the awarded Phase I contract is stated in the Statement of Work:

> . . . . This project will lead to a systematic methodology with which unconventional aircraft designs can be evaluated, using computer simulation, in a variety of operational environments. Such a technique will allow for the representation of significant aircraft characteristics, various levels of technology and design alternatives, operational and environmental factors, and constraints dictated by the user. The goal is to develop a system that will produce useful analyses that can be used in the advanced aircraft development process.

Specific study objectives were:

1. To conduct a survey and create a bibliography of relevant previous and ongoing studies;
2. To identify and evaluate alternative methodologies and assessment techniques; and
3. To recommend an approach and study plan for Phase II.

The duration of the Phase I contract was six months, from 01 July 1988 to 02 January 1989. The results are summarized below.

Objective 1

A variety of sources were referenced to identify existing models that might satisfy TXA's simulation requirement, including:

1. Defense Logistics Studies Information Exchange (DLSIE). Existing catalogs were reviewed and on line searches from the computer data base were obtained.
2. Defense Technical Information Center (DTIC). A data base search was performed.
3. Scientific and Technical Aerospace Reports (STAR). Report indexes for the 1978-1988 period were reviewed.
4. Computer Software Management and Information Center (COSMIC) Catalogue. Published by NASA beginning in 1984.
5. Federal Software Exchange Catalog. Published by the Department of Commerce beginning in 1977.
6. Various Technical Indices and Current Periodicals.

Several thousands of reports and simulation models were reviewed during the survey process. The models were categorized according to the following criteria:

1. Global. Models that simulate the operations of opposing forces, including both engagement and non engagement activities.
2. Specific Interaction. Models that simulate a specific aspect of the interaction of opposing forces, such as an aircraft/SAM engagement model.
3. System Specific. Models that simulate the operation of a specific system, such as radar detection model.

4. Logistics/LCC. Models that examine the cost, maintenance, or logistics support functions attendant to a weapon system.

5. Miscellaneous. Models that are of interest but do not fall into one of the above categories, such as a weather model.

6. Comparisons and Indices. Reports that compare two or more models, and various catalogs and indices for reference.

Several hundred of the models reviewed were selected for a general bibliography. A subset of those were included in an annotated bibliography. These documents are intended to be a reference and are structured so as to permit periodic updating as new models or modifications to existing models become available.

Objective 2

Eighteen of the models were classified as Global. Each model was then subjected to an evaluation process to determined if it contains the elements and characteristics desired for TXA use and if it can be modified or adapted with a reasonable effort. The analysis included elements such as simulation language, data input and preparation requirements, execution time, type of computer, memory requirements, model design and complexity, etc.

It was determined that none of the existing models are, in present form, satisfactory for the purposes desired by TXA. It was also found that the extent of an effort required to modify and supplement an existing model is inefficient when compared to that needed to develop a new model specifically designed to TXA needs.

Objective 3

Jordan and Associates has recommended an approach and study plan for Phase II of the project by the submission of an SBIR Phase II proposal. It details a two year effort, involving the development and installation of a computer simulation model. The proposal was submitted prior to the end of the Phase I effort, in accordance with SBIR Phase II proposal guidelines. This allows timely Air Force consideration of the proposal in order to minimize the delay between Phase I and Phase II.

SECTION 1
INTRODUCTION

This report documents the efforts expended under Small Business Innovation Research (SBIR) Project AF88-092, "Systems Level Technology Assessment Methodology for STOVL Type Aircraft." The project was sponsored by the Analysis and Concepts Division of the Technology Exploitation Directorate (TXA, formerly FIA). The proposal Statement of Work upon which the effort was based is contained in Appendix A.

An SBIR project consists of three (3) phases. Phase I is a feasibility analysis; Phase II is the development program; and Phase III is associated with commercial or other applications of the project. This report concerns the Phase I portion of the project. Proposed Phase II activity is discussed in Section 4 of this report.

SCOPE

The scope of this project is quoted from the solicitation notice:

> Phase I activity will include a survey of possible systems level technology assessment approaches including problem flexibility, ease of use, credibility, etc., and a recommended technique. This will lead to Phase II activities consisting of the final development including algorithms, data base, coding, validation, documentation and transition of the methodology to the Air Force Wright Aeronautical Laboratories.

OBJECTIVES

The overall objectives of the awarded Phase I contract is stated in the Statement of Work:

> . . . This project will lead to a systematic methodology with which unconventional aircraft designs can be evaluated, using computer simulation, in a variety of operational environments. Such a technique will allow for the representation of significant aircraft characteristics, various levels of technology and design alternatives, operational and environmental factors, and constraints dictated by the user. The goal is to develop a system that will produce useful analyses that can be used in the advanced aircraft development process.

Specific objectives of the Phase I effort were:

1. To conduct a survey and create a bibliography of relevant previous and ongoing studies and models;
2. To identify and evaluate alternative methodologies and assessment techniques; and
3. To recommend an approach and study plan for Phase II.

The remainder of this report consists of a discussion of the results of the above three tasks.

SECTION 2
SURVEY

An extensive survey was conducted to determine if an existing computer model will satisfy the simulation requirements of TXA, as previously described. A wide variety of sources were searched to identify existing models and models in development. Each model selected for further examination was then categorized according to scope and purpose. These were assembled into a general bibliography, by category. A selected number of entries from the general bibliography were then collected into a more descriptive, annotated bibliography. These two bibliographies and supporting, explanatory documents have been combined as Volume II of this report.

Government and non-government sources were referenced during the survey portion of the project. The University of Tennessee (UT) library, the Scientific and Technical Information (STINFO) library at Wright-Patterson Air Force Base (WPAFB), the Defense Technical Information Center (DTIC), and the Defense Logistics Studies Information Exchange (DLSIE) were the main repositories consulted. Other sources included open source compendiums, periodicals, indexes, journals, and bulletins. A list of the referenced sources is contained in Appendix B.

Among the services provided by DTIC and DLSIE is a search using key words to identify applicable entries in the data base. An on-line search was made of the DTIC data base with the help of STINFO library personnel. A DLSIE search was performed by coordinating information requirements with staff technicians at the DLSIE center in Fort Lee, Virginia. Follow-up requests for additional information were also made to the DLSIE system.

The various library facilities of STINFO and UT, including computer based search systems, were frequently used in the attempt to make the survey as comprehensive as possible.

An attempt was also made to access the Industry IR&D library at WPAFB. Many defense contractors develop simulation models for internal applications using Independent Research and Development (IR&D) funding from one of the federal government departments or agencies. The Departments of Defense, Energy, and Transportation are major sponsors of IR&D programs.

The IR&D efforts are documented in annual reports that are submitted to the appropriate monitoring agency, which includes, for the Department of Defense, the Air Force, Army, and Navy. The reports are then evaluated by the monitor and retained for future reference. Those reports could serve as a source of methodologies and models with potential applicability to TXA requirements.

However, Jordan and Associates was not permitted access to the reports, for three reasons. First, the reports are proprietary in nature and thus not releasable to non-USAF agencies. Second, the reports are often classified and this effort is unclassified. Finally, an unambiguous need-to-know could not be demonstrated.

It was also not possible to review potential sources that are classified. This restriction was not considered serious, however, because very few models are classified unless data is entered. Most model for which the <u>coding</u> is classified are concerned with nuclear, chemical or biological warfare, or intelligence gathering methods or analysis.

The survey resulted in the review of thousands of models and reports. Those models having a potential usefulness to the objective of the project were entered into a general bibliography, which is contained in Volume II of this report. Three hundred and fifty-one sources are entered in the general bibliography.

The models and reports were grouped according to topic, scope or function. Six categories were used:

1. Global. This category contains models that simulate the entire functional aspects of a major weapons force, such as an Air Force or an Army. The key element of this category is that the model attempts to simulate the operation of the system in its entirety, including both engagement and non-engagement activities. Maintenance, support, and logistics must be treated, however minimally. The model may be one-sided or two-sided, that is, the simulated force may oppose a likewise simulated force or simply a parametric opponent. The level of sophistication of a global model will range from very simplistic to very complex.

2. Specific Interaction. Models in category simulate a specific portion of the interaction of opposing forces. They are similar to global models except that not all aspects of the operation of a weapons force are considered. An example would be a model that simulates the interaction of a penetrating fighter and a SAM site. Similar to global models, specific interaction models will range from very simple to very complex.

3. System Specific. The models in this category are those that focus on the operation of a specific system of a weapon. For example, a radar detection model or a landing gear simulation for an aircraft would be in this category. These models are usually fairly complex. They may include an interaction with an outside element, but only for the purpose of simulating the function of the system, not its performance.

4. "Ilities" and Cost. This category contains models that are concerned with "operational suitability" factors, such as reliability, maintainability, supportability, logistics, life cycle cost, manpower, etc. Engagement functions are either not considered or treated only in enough detail to stimulate the operational suitability aspect under investigation.

5. Miscellaneous. This category contains models and topics of general interest that cannot be placed in one of the above four groups. A model may be included in this category because of its

potential usefulness to the program objective, such as a weather model, or because it contains a special methodology worthy of examination.

6. Comparisons and Indices. It is not unusual that several different models are designed to examine essentially the same problem. Comparisons among those models is a natural result. Several such comparisons have been performed for major Air Force models. The results are occasionally documented. Catalogs and compendiums of models held by various organizations are published periodically to advertise capability. A number of these are listed in this section.

Except for global models, not every model identified as applicable was included in the general bibliography contained in Volume II. It was considered unnecessary and redundant to list several models addressing identical topics. In that case, one or two of the most representative models were selected. It must be emphasized that the general bibliography in Volume II is by no means exhaustive. It does, however, contain contain a large and very representative sample of the types of models available.

Of the models listed in the general bibliography, a large subset was selected for more detailed description in an annotated bibliography. All of the global models are so described. Others were selected based upon their function and scope. Most of the specific interaction models are included.

In order to avoid repetition and to reduce the length of the general bibliography, a set of acronyms was created to represent authoring and sponsoring agencies for the documents. Definition of those acronyms, including addresses when available, are presented in Section 3 of Volume II.

Volume II is packaged in loose leaf form. It is intended to be used as a reference and is structure to facilitate periodic updating as new models or modifications become available.

SECTION 3
ASSESSMENT AND EVALUATION

Twenty-eight references concerning eighteen models are listed in the global category. When evaluated during the survey portion of the study, these models were considered as candidates for immediate application, or for modification to a form suitable to meeting the requirements of TXA. An evaluation was undertaken to determine if either of the above options is feasible or practical.

Computer models have characteristics, such as the programming language used, execution time, amount and time to prepare and input data, type of computer required, memory requirements, design and complexity, comprehensiveness, etc. The combination of those factors determines the usefulness of a model; that is, by whom, for what purpose, and how often it can be used.

The characteristics of a model can be compared to the set of modeling requirements of a potential user to judge the model's applicability to that purpose. This technique was used to judge the global models identified in the survey.

TXA has a specific set of requirements for the methodology it seeks in this project.

The model must, first of all, be compatible with the computing equipment available. At present, the Air Force has both mainframe type computers and tabletop computers, the latter being primarily the Zenith model 248. At TXA, the Z-248 can operate on a stand alone basis and in a network mode.

One of the principal responsibilities of TXA is the evaluation of technology alternatives for aircraft systems. The alternatives range from conceptions of entire aircraft and supporting systems to individual subsystems or components of aircraft.

The evaluation process includes both feasibility and utility functions. Feasibility of a concept pertains to its impact on operational suitability; that is, the aircraft, maintenance, and supporting structure associated with a weapon system. Utility is more oriented toward operational effectiveness; that is, the value of the concept in the actual combat or operational performance of the aircraft.

To support the evaluation function of TXA, then, a model must be capable of simulating a wide range of technology alternatives and do so within a practical operational environment that considers all, or at least most, of the elements that could influence the desirability, or lack thereof, of a particularly technology.

Furthermore, the technologies to be considered can include variations from complete systems, such as the STOVL type aircraft that are indicated in the title to this project, to specific subsystems or components in existing aircraft.

TXA is also frequently required to perform quick analyses of systems or alternatives in response to requests from other organizations or agencies involved in the aircraft development process. Thus a fast response capability and ease of use is desirable for the model.

To be useful, a model must be credible; that is, its output must be reasonable and generally viewed as an acceptable outcome for the problem being studied. When that is the case, the model becomes an accepted means of portraying, or modeling, the real process.

Models become credible through a validation process of either achieving the same results through simulation as observed in reality, or by wide scale use over time. Models are quickly discredited if they produce unreasonable results that defy common sense and experience. For TXA to effectively perform its function, any model it uses must be credible.

The eighteen models identified in the survey were evaluated in these and other areas, as shown in Figure 1. Each model was given a score in each category.

"Y" - The model meets the requirements of TXA in the category.

"N" - The model does not meet the requirements of TXA in the category or has an unacceptable feature, neither of which can be corrected by reasonable modification of the model.

"O" - The model does not meet the requirements of the "Y" category but can be modified with a reasonable effort.

The characteristics evaluated are as follows:

A: Simulation language
B: Computer hardware requirement
C: Operating system requirement
D: Input data preparation and model setup time
E: Computer memory requirement
F: Execution time
G: Scope
H: Level of detail
I: Type and quality of output
J: Credibility and extent of use

Several of these characteristics have multiple elements. The score indicates the least favorable result of the evaluation and may pertain to more than one element.

Each of the models listed in the grid is described in the annotated bibliography in Volume II.

	Characteristic									
Model	A	B	C	D	E	F	G	H	I	J
ALBS	Y	O	O	N	Y	Y	Y	N	Y	Y
ATLAS	Y	O	O	N	Y	N	Y	N	Y	Y
DETEC	Y	N	N	Y	N	N	Y	Y	Y	Y
FAST STICK	Y	O	O	N	Y	N	Y	Y	Y	Y
HACES	Y	O	O	Y	Y	Y	N	N	Y	Y
INBATIM	Y	O	O	N	Y	Y	Y	O	N	Y
JTLS	Y	O	N	N	N	N	Y	N	N	Y
MTOM	Y	O	O	Y	Y	Y	Y	N	Y	Y
MULTIX	Y	Y	Y	Y	Y	Y	Y	N	N	Y
NAVMOD	Y	O	O	Y	Y	Y	N	N	Y	Y
OPTSA	Y	O	O	Y	Y	Y	N	N	Y	Y
SGM	Y	O	O	N	Y	Y	Y	N	Y	Y
SORTY30	Y	O	O	Y	Y	Y	N	N	Y	Y
TAC THUNDER	Y	O	O	Y	Y	Y	N	N	Y	Y
TAC WARRIOR	Y	O	O	N	Y	N	Y	O	Y	Y
TRACE	Y	O	O	Y	Y	Y	Y	N	Y	Y
TSAR	Y	O	O	N	Y	Y	Y	N	Y	Y
TWX	Y	O	O	N	Y	N	Y	N	Y	Y

Figure 1: Model Evaluation Grid

As the grid shows, each model has an unacceptable category. Some discussion of the results follows.

All but one of the models was developed for use on a mainframe computer. However, the capacity of current, state of the art micro- and minicomputers is such that most models can be adapted.

Also, most models were coded in Fortran, although several used Simscript and one used Basic. These languages can be readily adapted to tabletop versions.

Input requirements proved unacceptable in half of the models. Some required as much as six to nine months of data preparation time to set up a single scenario. This is clearly unacceptable for TXA purposes.

Level of Detail proved to be the category which accrued the most unacceptable scores. Most models that are written for a theater level application do not address weapons systems at a sufficient level of detail to satisfy TXA requirements. Further, the programs are generally written in a manner that would not readily permit modification or insertion of greater levels of detail throughout the model.

Two of the models, MTOM and TRACE, have only one unacceptable characteristic. Unfortunately, the unacceptable category is Level of Detail, for reasons explained above.

Thus, none of the existing models are satisfactory for the purposes desired by TXA. Furthermore, none can be modified with a reasonable expenditure of effort.

Another approach to this problem is to select a suitable model from the specific interaction category and expand model to provide the desired capability. However, such an effort would be little different from creating a new model in terms of time and labor, and may in fact preserve some undesirable or inefficient features of the existing model.

A third option would be to attempt to combine several existing models with an integrating algorithm. It is unlikely that such a task would be successful, given the differences in format, logic flow, data requirements, or coding that always exist among models.

Therefore, the conclusion reached as a result of the analysis is that the preferred approach is the creation of a new model specifically designed to meet TXA requirements.

SECTION 4
RECOMMENDATION AND PHASE II PLAN

Jordan and Associates has recommended an approach and study plan for Phase II of the project by the submission of an SBIR Phase II proposal.

The proposal details a two year development effort, in which the objectives described above will be achieved. A computer simulation model for the purpose of evaluation and analysis of technology options and alternatives in aircraft and associated systems will be designed and developed.

The proposal presents a detailed study plan and work breakdown for the development effort. It was submitted prior to completion of the Phase I effort, in accordance with SBIR Phase II proposal guidelines. This will allow timely Air Force consideration of the proposal in order to minimize the delay between the end of Phase I and the beginning of Phase II.

If Phase II is not funded or if the Air Force decides to develop the model internally, the study plan in the proposal can be used as a guide.

TITLE: Systems Level Technology Assessment Methodology for STOL Type Aircraft.

SBIR Project AF88-092.

IDENTIFICATION AND SIGNIFICANCE OF THE PROBLEM

In general, USAF aircraft are designed to provide broad capabilities within a particular combat mission category. For example, the specifications leading to development of the F-15 required both intercept and dogfight capability, thereby meeting the numerous offensive and defensive demands of the air combat mission. The A-10, on the other hand, was designed specifically to meet the anti-tank segment of the Close Air Support mission category. Similar statements can be made to describe the development of other fighter and transport aircraft in the USAF inventory.

It appears, also, that the designs of current aircraft are heavily influenced by the elements and conditions of either the most recent war (Vietnam) or the most dangerous possible war (NATO/Europe or Korea). Hence, the present USAF inventory consists of tactical aircraft that provide substantial capability, but require considerable logistical support, large air fields, and extensive command and control, all of which are available in the NATO or Korean environments. As a result, the USAF has found it difficult or impossible to use its TACAIR forces in a number of situations in which those assets might have been useful to support national interests. Examples include the Grenada and Lebanon operations and the current Persian Gulf presence.

To broaden its capability to respond to unconventional situations, the USAF has examined and continues to examine alternative design concepts, such as STOL, STOVL, and VTOL. These have been rejected in the past because the attainment of short or vertical capability resulted in too severe a penalty in other performance areas. The current AV-8B design is a good illustration of this point.

As indicated by the above comments, however, it may be appropriate for the USAF to reevaluate alternative designs. To provide meaningful results, this evaluation must consider the various concepts from the perspective of overall TACAIR capability, rather than only in terms of specific performance criteria. The thrust of this project is toward that effort.

It would be possible to simply choose one of the several existing methodologies and restructure it to provide the desired capability. That approach would entail certain risks. The selected technique may not be the most suitable for the task; indeed, it may be that none of the existing techniques are suitable and new methodology requires development. Thus, considerable effort could be expended for naught. On the other hand, if adaptation were successful, it may actually duplicate some other effort, resulting in a needless expenditure of money and time. To avoid these pitfalls, a systems analysis is dictated. Properly conducted, the analysis will result in the selection of the most suitable, or optimum, approach to the problem, one that can be obtained efficiently and will satisfy the needs and requirements of AFWAL. The study effort addressed in this proposal is designed to that end.

Specifically, this project will lead to a systematic methodology with which unconventional aircraft designs can be evaluated, using computer simulation, in a variety of operational environments. Such a technique will allow for the representation of significant aircraft characteristics, various levels of technology and design alternatives, operational and environmental factors, and constraints dictated by the user. The goal is to develop a system that will produce useful analyses that can be used in the advanced aircraft development process. As stated in the solicitation notice, the effort will consist of two phases: evaluation and recommendation of an appropriate methodology in Phase I and program development, documentation and implementation in Phase II.

This submission addresses proposed efforts for Phase I.

PHASE I TECHNICAL OBJECTIVES

Specific objectives of this effort are:

(1) To conduct a survey and create a bibliography of relevant previous and ongoing studies;

(2) To identify and evaluate alternative methodologies and assessment techniques; and

(3) To recommend an approach and study plan for Phase II efforts.

The principal question that will be answered as a result of this study is whether or not a suitable methodology can be developed, procured, or adapted for internal AFWAL use. Other, subsidiary aspects include:

(1) What are the hardware and software requirements? Is existing AFWAL equipment sufficient or is new equipment required?

(2) What costs are involved? For installation? For operation?

(3) What utility will the recommended technique have in advancing AFWAL's objectives and charter?

PHASE I WORK PLAN

The approach proposed for this study is detailed in this section. It consists of three consecutive tasks: a survey to compile information, an evaluation of the data, and a recommended methodology and plan for Phase II.

Figure 1 presents a diagram of the approach.

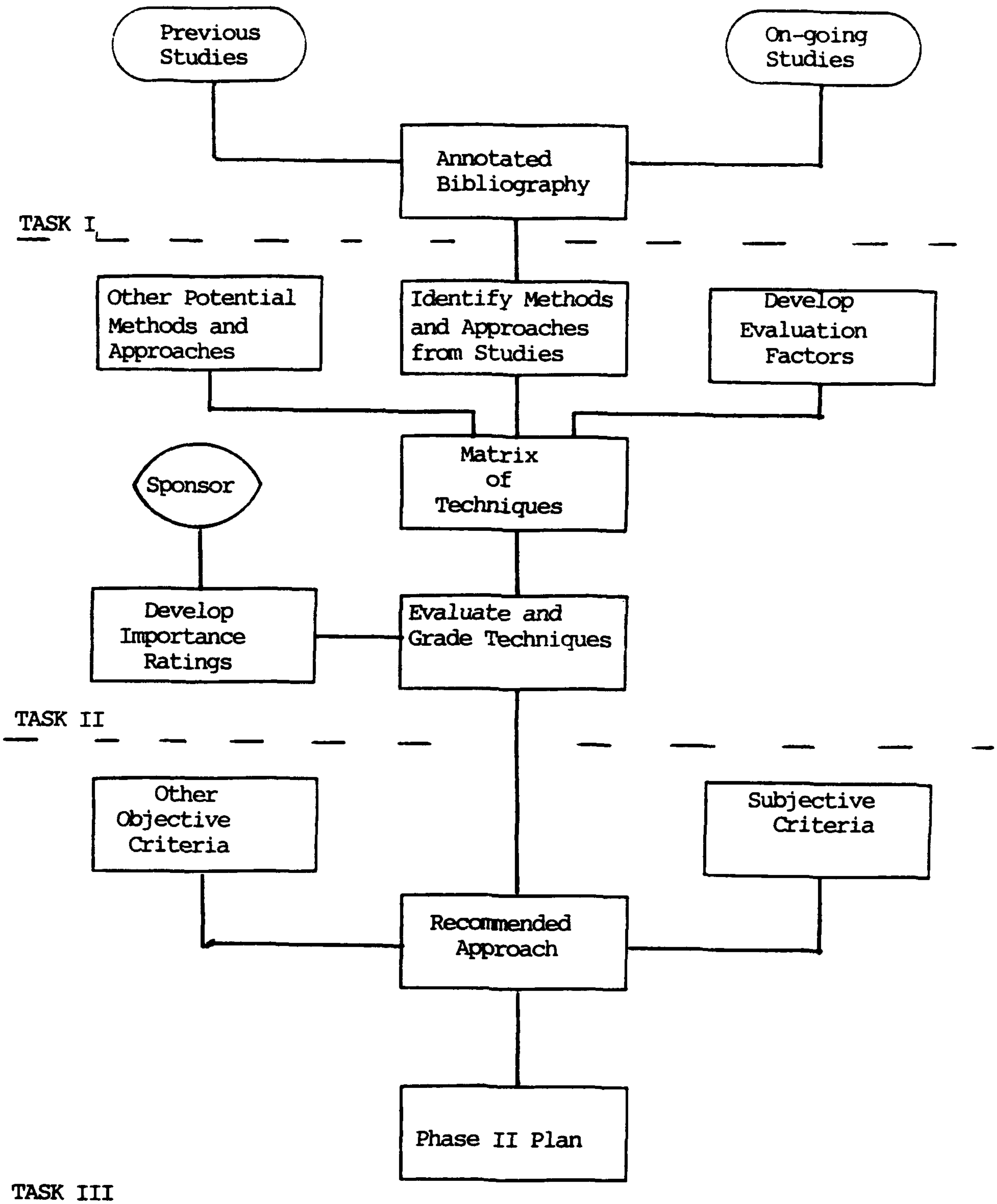

Figure 1: Study Approach

Task I: Survey

There have been a multitude of government and industry sponsored studies over the years concerning STOL and STOVL type aircraft. These studies have usually focused on the applicability of the aircraft in conventional scenarios. Two recent exceptions are the AFWAL sponsored "Global Tactical Presence" study (1986) and the recently completed, ASD sponsored "High Reliability Fighter" study, in which concept aircraft were examined in a variety of unconventional settings.

The first step in this effort is to identify as many of the previous and on-going government and industry studies as possible. This will be accomplished by a literature survey and by a review of both internal and contracted on-going government sponsored studies. Current industry sponsored studies will be more difficult to identify, but an attempt will be made, using industry sources, journals and bulletins, and other available materials.

Once compiled, the information from the survey will be formed into an annotated bibliography listing the study, contract, or research effort, the investigator and/or sponsor, the purpose and thrust of the activity, and significant details of the study applicable to this project. The bibliography document will be a deliverable in a form suitable for reproduction or publication.

The majority of this task will be performed at AFWAL, using the library and DTIC facilities available there. The remainder will be done using the library facilities of the University of Tennessee at Knoxville. Three weeks of effort will be spread over a two month period. This will allow for flexibility in scheduling and for delays in obtaining required material.

Task II: Assessment and Evaluation

This investigator is confident that several existing methodologies will meet the stated objectives of the effort. However, each methodology imposes specific requirements and costs.

Thus, a meaningful comparison of the methodologies is necessary to permit an informed selection decision. This task is designed to accomplish that objective.

It is likely that Task I will produce a number of methodologies and assessment approaches that have been used to evaluate the utility of STOL/STOVL type aircraft. Some will be strictly aircraft performance oriented and others will be more operationally oriented. In addition, some of the techniques from individual studies may be essentially identical and can therefore be grouped into a single classification. Also, potential techniques that do not appear from the survey will be included, if appropriate, in the list.

Each of the technique classifications will then be described according to significant characteristics, such as hardware requirements, ease of use, ease of including significant variables, adaptability, comprehensiveness, level of detail, credibility, cost to operate, etc. Each characteristic will be defined in terms that allow assignment of a grade for the specific technique. For example, "ease of use" may be scored as "good" (+1) if input requirements are minimal and immediate output is provided, "fair" (0) if input and output time exceeds one hour, but are less than one day, and "poor" (-1) if the time exceeds one day. The specific characteristics and their definitions will be developed during the study.

This process will result in the creation of a matrix of techniques, similar to that shown in Figure 2.

Once the matrix is formed, relative weighting factors, or "importance ratings" will be developed and overlaid on the matrix to give appropriate weight to each of the characteristics. The importance ratings will be developed through coordination with the study sponsor, giving AFWAL the opportunity to prioritize and give emphasis to the the characteristics according to its specific requirements. The result will be a weighted grade for each of the techniques.

Three weeks of effort over a two month period are allocated for this task, allowing for interface with and comment by AFWAL.

Task III: Recommendation and Phase II Plan

The results of Task II will be combined with subjective and other objective criteria to provide a recommended methodology deemed, by the principal investigator, most appropriate to meet the needs of AFWAL, as stated in the solicitation notice and further defined during the study effort.

Included in this task will be a "strawman" study plan for the Phase II activities, using the recommended methodology. In the event Phase II is not funded, this plan will give AFWAL a basis upon which to conduct its own, internal development activities when desired.

	CHARACTERISTIC				
TECHNIQUE	EASE OF USE	HARDWARE REQUIRE-MENT	LEVEL OF DETAIL	CREDIBILITY	
A					
B					
C					

Figure 2: Sample Matrix

Again, this investigator is confident that a very suitable and appropriate methodology for this project can be efficiently developed. A specific example known to this investigator is the methodology and program developed for the Global Tactical Presence (GTP) study. If it scores well in Task II of this Phase, the GTP program would be a very likely candidate to be adapted for investigating the operational benefits of STOL/STOVL aircraft.

Two weeks of effort over a two month period are allocated for this task. This will allow time for AFWAL feedback and comment on the final report.

Documentation

This study will be documented as it is performed. The schedule and cost proposal reflect concurrent documentation. There will be two deliverables: An annotated bibliography and a final report. The final report will detail the results of each task and provide comments and recommendations.

Schedule

The proposed schedule for this project is shown in Figure 3.

```
[-----------------] Task 1
                  [-----------------] Task 2
                                    [-----------------] Task 3

_______________________________________________________
0        1        2        3        4        5        6
                  Months After Contract Start
```

Figure 3: Study Schedule

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